SP-0108
Multi-parametric MRI and PET imaging for dose painting in head-and-neck cancer
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The benefit of dose painting in the head-and-neck (HN) area is currently being investigated in several clinical trials. In these trials, dose painting is based on a single imaging modality, ^{18}F-fluorodeoxyglucose positron emission tomography (FDG-PET). FDG-PET identifies aggressive or radiation resistant subvolumes, as it represents the cumulative effect of multiple adverse tumor characteristics, such as high cell metabolism, proliferation, expression of key oncogenes, and hypoxia. Other PET tracers and (functional) magnetic resonance imaging (MRI) techniques that visualize the complex and heterogeneous biology of the tumor have been published.
The key question is which (combination) of these imaging modalities are relevant to guide dose painting in HN cancer and how will we gain this knowledge?
First of all, we need to investigate whether different imaging techniques identify the same or different target volumes for dose escalation. Secondly, for the imaging techniques reflecting different targets, the relation between imaging parameter and required dose needs to be defined. To avoid a large amount of trials, multiple imaging techniques of interest can be combined in clinical trials. Together with extensive follow-up imaging, this will open up the possibility to relate tumor areas requiring a higher dose to the functional imaging parameters.
As an example, we investigated in 18 patients with a HN tumor whether target volumes defined using FDG-PET or DWI are the same or different. Furthermore, the dose coverage of DWI targets in FDG-PET-based dose painting plans was analyzed. To this end, the FDG-PET target for dose painting was determined as the area with a standardized uptake value (SUV) above 50% of the maximum SUV in the GTV, as is typically done in ongoing trials. For DWI, the relation between the apparent diffusion coefficient (ADC) and the required dose is not clear yet. While a low ADC value is indicative of tumor presence, others reported that a higher ADC within the tumor is associated with worse outcome. Therefore, we determined different ADC target volumes, with values above and below the mean ADC value within the GTV.
The correspondence between these imaging techniques in the GTV, determined on a voxel-level using Spearman's correlation coefficient, varied between positive and negative correlations (ρ ranged from -0.6 to 0.4). The dose coverage of all ADC-targets was significantly reduced compared to the coverage of the FDG-PET-target (D_{mean}(SUV) = 81 Gy, D_{mean}(ADC) = 75-77Gy; $D_{98\%}$(SUV) = 77 Gy; $D_{98\%}$(ADC) = 70 Gy). This could mostly be explained by the partial overlap between the volumes.
In conclusion, different imaging modalities can contain different information, resulting in different targets. Further knowledge about failure patterns and relations between the required dose and imaging parameters need to be obtained by adding such imaging techniques to dose painting trials.

SP-0109
F-choline PET/CT for prostate cancer
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Choline is an essential part of the cell wall, and substantial amounts are required for cellular proliferation. The biodistribution of choline can be visualized in vivo by introducing a radioactive label suitable for positron emission detection (PET), either 11-Carbon or 18-Fluor. The accumulation of radiolabeled choline on PET/CT provides a visual representation of cell proliferation. This technique can be applied to detect tumour types that proliferate but tend to be FDG-negative, such as prostate cancer. Choline PET/CT has some drawbacks that need to be considered. It is relatively expensive, it comes with a radiation burden, and it can only detect macroscopic tumor lesions. Therefore, it is important to properly select patients with a high chance of clinical impact.
Since normal prostate gland tissue tends to accumulate choline for physiological purposes, discrimination of a primary tumour within a functioning prostate is difficult and may be unreliable. After treatment of prostate cancer, either with prostatectomy, external beam radiotherapy or brachytherapy, there no longer is functional prostate gland tissue in situ and detection of a local recurrence is reliable. Therefore, the main application of Choline PET/CT for prostate cancer is restaging at the time of PSA relapse. In addition, regional lymph node metastases and distant metastases can be detected with good accuracy. To further maximise diagnostic yield, criteria can be used to select patients with a good chance of visible macroscopic tumor, including PSA thresholds and Gleason score.
The clinical impact of Choline PET/CT for restaging of recurrent prostate cancer is twofold. First, in cases where salvage prostatectomy or salvage radiotherapy is considered, the detection of regional or distant metastatic disease may switch treatment to systemic options, and avoid unnecessary aggressive invasive procedures with high cost and toxicity. Second, some patients may present with oligometastatic disease, where radiotherapy may find a new role with SBRT, aiming for high local control and postponing hormone treatment with potentially several years. In conclusion, in properly selected patients with recurrent prostate cancer, Choline PET/CT may guide treatment decisions to improve quality of life.
Further research may focus on the application of Choline PET for radiotherapy planning and dose painting. Once the location of tumor tissue is known, e.g. as determined on MR, PET, US or biopsy, the local choline influx may be related to the radiation dose required for tumor sterilization. However, to allow such an approach, more knowledge is needed on the relations of functional imaging parameters from various imaging modalities with radiobiological tumor characteristics.

DEBATE: ELECTRONS, THE LOST PARTICLE: ARE THEY STILL IN CHARGE?

SP-0110
Electrons, the lost particle: Are they still in charge? - For the motion!
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Electrons should be used in an integrated planning and delivery procedures together with photons!
Electrons do not spill dose behind the target which significantly reduces the extra-target dose. Electrons can also deliver superficial dose without adding bolus. However, the electron penumbra is not so sharp at depth; this is where the modulated photons can help.
So, what needs to be done?
The planning systems must be developed to optimize both electrons and photons together. The fully computer controlled therapy accelerators must be able to deliver both electrons and photons with the same MLC. The accelerators must also allow for fast energy switching within the same sequence.
The feasibility of this mixed-beam concept has been shown by several authors in the scientific literature.

SP-0111 Against the motion
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Electron beam radiotherapy has more use in selling high energy radiotherapy machines than it has to treat patients. Before intensity-modulated radiotherapy (IMRT) electron beams were used in about 5% of radiotherapy treatments. With the advent IMRT, the role of electron beam radiotherapy has greatly diminished for a number of reasons. Most importantly, many lower head and neck treatments that used both conformal photon beams and electron beams now are only using only IMRT photon beams because the plans are both better and easier to do. Other examples of treatments that can be done with photon IMRT alone are breast radiotherapy with internal mammary chain node boost or skin boost. When electron treatments are performed the tumor homogeneity is poor and the dose uncertainty is very high. Treatments that were once electron-only can now often be done better with IMRT. Examples include total scalp treatment and even small complex electron fields. Photon beam treatment planning accuracy has improved so much that it is not even always necessary to apply a bolus to the skin but rather the buildup is obtained by tangential fields. Conversely electron beam dose computation has more uncertainty than IMRT dosimetry. Likely less than 1% of patients, who are treated at centers which are fully IMRT capable, have electron beams applied to them and many of these treatments are for palliative or non-life threatening treatments like refractory planters warts. The cost of multi-energy and multi-modality radiotherapy equipment is much more than low energy units even with a full IMRT capability. A principle of industrial engineering that seems to be lost in radiotherapy is that all equipment in an industry does not have to be designed to be applied universally. There should likely be one electron capable machine in the largest cancer centers but to have most machines capable of treating electrons is wasteful and in the future unsustainable.

SYMPOSIUM: ADVANCE PRACTICE FOR RTT RESEARCH: THE GEOMETRIC UNCERTAINTIES CASE

SP-0112

The national radiotherapy strategy in England: supporting implementation of national recommendations

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Each country in the UK England, Scotland, Wales and Northern Ireland has its own health policy related to the development of services within the National Health Service (NHS). This presentation focuses on work undertaken within England in relation to NHS Radiotherapy service provision.

In England there are 50 NHS Radiotherapy providers, with radiotherapy services provided on 58 clinical sites. The presentation will describe how a nationwide approach is helping support implementation of equitable high standards for patients across England.

To enable this approach government established a National Radiotherapy Advisory Group to advise government ministers. This group comprised professional representatives from each discipline, health care commissioners, patients and lay representatives and policy advisors from the Department of Health. The group made recommendations in the Report to Ministers in 2007 "Developing a world class Radiotherapy service for England" [1].

The report made wide ranging recommendations about all aspects of service delivery including importantly standards of care related to technical service delivery. A National Radiotherapy Implementation Group (NRIG) was established to oversee and support implementation of the recommendations[2]. In 2011 the government set an ambitious goal to improve cancer patient's outcomes, a national strategy Improving Outcomes: A strategy for cancer was published[3]. This policy document built upon the radiotherapy NRAG recommendations and recommended an increase in capacity, and implementation of the most up to date treatment technologies across England stating " to improve outcomes from radiotherapy, there must be equitable access to high quality, safe, timely, protocol driven quality controlled services focused around patients' needs".

This presentation focussing upon this work from 2007 to 2013, will describe the development of programmes and workstreams to support the implementation of the technical recommendations made within NRAG report.

NB Specific details relating to the NRIG IGRT support programme will be provided by June Dean and Mark Elsworthy, National IGRT leads, Society of Radiographers and National Cancer Action Team in a paper within this session at ESTRO.

1. NRAG (2007) *Radiotherapy: Developing a world class service for England* , Report to Ministers from National Radiotherapy Advisory Group 26 February 2007. Accessed on line
http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_074575

2. Department of Health (2012) *Radiotherapy Services in England 2012*. Department of Health. London. Accessed on line
https://www.wp.dh.gov.uk/publications/files/2012/11/Radiotherapy-Services-in-England-2012.pdf

3. Department of Health (2011) Improving Outcomes: A Strategy for Cancer. Department of Health. London. Accessed on line
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SP-0113

Data collection and management in RTT research on geometric uncertainties

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The employment of advanced image guidance techniques in clinical radiotherapy practice has ensured that geometrical uncertainties during treatment have been reduced. Hence, new techniques such as IMRT, and VMAT performed in a stereotactic setting can be applied safely with smaller margins.

In our institute, the development of new radiotherapy (RT) techniques generally starts with retrospective studies on existing patient data. For example, to determine the required safety margin for a certain protocol, historic data will be analysed to determine organ motion, setup errors, and delineation variability in relation to the new protocol. To facilitate this, all patient imaging data are saved in databases and archived after patients have finished their treatment. Radiotherapy technicians (RTTs) often play an important role in collecting and managing these patient data, not only during treatment but also in its retrospective analysis.

The collected data are analyzed by a research RTT, in close cooperation with a physicist and/or physician. This is followed by a proposal for introduction into the clinic, accompanied with a clinical implementation protocol. An IGRT implementation group, consisting of physicists, radiation oncologists and RTTs will guide and define the complete process from research to clinical implementation. After clinical implementation the newly developed technique is supervised by dedicated imaging RTTs until the technique is sufficiently imbedded in daily clinical practice. Once all other RTTs are sufficiently trained, the technique is fully implemented. During the whole process the technique will be evaluated and improvements can be made.

To illustrate this procedure: We investigated the use of an optical imaging system (AlignRT) for monitoring the breath hold state of the patients during deep inspiration breath-hold RT. Data of 20 patients were collected and retrospectively analyzed to investigate geometric uncertainties such as inter-fraction, intra-fraction- and intra-beam variability. The results were used to evaluate the current kV guided breath-hold protocol and a number of adaptations were made as a result.

SP-0114

The role of the UK IGRT lead RTTs and outcome of the UK implementation program

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A report to ministers in 2007 by the national radiotherapy advisory group proposed a vision for future radiotherapy; that all new linear accelerators would be capable of 4D Adaptive Radiotherapy and this would become the standard of care in the future.

A new document was required to support the wider adoption and application of image guided radiotherapy (IGRT) to enable the future implementation of 4D adaptive radiotherapy throughout England.

The national implementation strategy proposed that IGRT support leads would be sent to each centre in England that requests support. The leads would be members of a multi-professional team consisting of oncologists, physicists and radiographers.

Radiographers are providing on- site support in developing protocols, work instructions and training and reviewing current practice. Physics support is provided by 3 English centres and is an outreach service via e-mail or telephone. Oncologist support will be directed appropriately by the co-chair of the new IGRT guidelines group.

The exit strategy of the IGRT Leads will be to generate a report on the current level of IGRT accessibility in England and a second for manufacturers regarding the functionality of the equipment with user feedback.

Data will be presented regarding common themes of support provided.

SP-0115

Combining research and clinical work - a radiation technologist's experience of multi-tasking

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The professional role of radiation therapy technologists (RTTs) has changed tremendously over the last two decades. This presentation will give a brief overview of these changes in the Netherlands, and discuss the training requirements to become an Advanced RTT Practitioner (AP) as well as some of the roles open to the AP in this country. A personal perspective is presented on studying for a Master's degree that focused on image guidance for stereotactic spine radiotherapy alongside clinical work, and subsequently on combining research and clinical work in an academic medical centre.

In order to become an AP, an RTT in the Netherlands is expected to undertake a Master's degree in a relevant aspect of radiotherapy in addition to possessing the necessary clinical experience and personal attributes. Working with senior management to define their role, advanced RTT practitioners are increasingly active in professional training and education, research and development, and improving and delivering high-quality patient cancer care. They may take on extended clinical responsibilities in areas like image guidance and advanced treatment planning for example, perform some of the tasks